THE MACRO PROTO PROPOSAL

The document before you is an early draft of a grant proposal, or more probably, a series of grant proposals. It is also a relatively inconvenient (but at least on paper) forum for some of my thinking about man-machine interactions and man-machine education. The section on evaluation is the most shakey section. Help and suggestion in this area are most needed.

What I would like you to do is to read the document (it's triple spaced and narrow margins, please don't be afraid of its weight) and respond by writing in the margins crossing out, rewriting, making a video or audio tape or any method you may find convenient. In essence, I am asking for your help and aid in clarifying my thought, writing or improving the effectiveness of the ~~porposal~~ proposal. (Loud cheers, if any, will also be accepted.)

Thank you much for any attention you can give this task.

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This is a proposal to develop a series of educational machines. The structure of these machines differs greatly from the structure of either teaching machines or demonstration machines PRESENTLY used in the educational system~~, presently~~. ~~But~~ HOWEVER before discussing the structure of these new machines I would like to direct attention to some issues in education which form the context of the development of these machines.

" EDUCATIONAL"
BEGS DEFINITION

WOULD BE INTERESTING
IN POLITICAL/SOCIAL
MOTIVATIONS

WHY EDUCATIONAL MACHINES AT ALL

The reason for using educational machines is similar to the reasons for using machines elsewhere i.e. to do something that is already being done cheaper or better or to do things that cannot be done presently. The public educational system is incredibly labor intensive. The average capitalization of the public school system is $10/per participant while a modern communication company may have a capitalization of $20,000/per worker. The hope is, of course, that by the development of, and, the investment in the appropriate educational machines, then, the whole system will become economically efficient.

In the transfer of the content of courses previously taught by humans to machines there is much implicit and incidental learning which is not transfered. In addition, there are new kinds of information generated by the technology itself

which needs to be learned. It is in these areas that many criticisms of teaching machines are levied and where much work is needed.

GENERALIZED MACHINES:

The advent of generalized machines is quite recent. In the past a tool was developed for (or developed by doing) a single or small set of tasks. The greater part of the industrial system is patterned after this. A car factory not only just makes cars, but just makes one kind of car, and has to shut down for extended periods to change to new yearly models. It apparently takes a long time to learn how to use generalized machines in a generalized way.

A tool which is used in a fairly generalized way is the pencil. It is used to write novels, sketch pictures, take notes, doodle, write text books, draft precise plans, write letters, and more.

Television has the same potential generality, and can do things corresponding to novels, sketches, notes, doodles, textbooks, etc., but is now only used to do novels and an occasional textbook (with the notable exception of real news-time and sports coverage).

Probably the most impressive generalized machine in our culture is the general purpose digital computer. The programs in modern computers change - - from one task to a completely disrelated task at 1/60th second intervals. The machine can be drawing the floor plan of a house, solving engineering calculations writing a report, and translating a language, all at apparently the same time. This, however, is

deceptive generality. From the user's point of view the computer is a set of special purpose tools. The user cannot typically come to the computer with a generalized problem and use generalized methods to solve it. He must call on a series of highly specific routines to deal with parts of the problem.

MACRO-GENERAL

A generalized device is not simply one which can solve a large range of problems but which has a high probability of solving tasks for which it was not specifically designed. In the case of computers it must be re-programmed to deal with problems significantly different than the ones for which the program was originally designed.

For ecological and efficiency reasons, generalized machines and processes will become

ALSO, DE-SPECIFICATION
of INFORMATION

more necessary and more used. It is necessary for people to learn how to use generalized machines and processes.

In addition to learning how to use generalized machines it is necessary that work be done in deciding how our generalized machines of the future are to behave. How can they be designed to enhance our consciousness? How can they be designed to be less rigid and less demanding on us? How can they be organized to be true adjuncts to our consciousness? It is common parlance to talk about how dehumanizing our machines are. Although high technology is probably necessary to solve many human problems now confronting us, there is a large anti-technological attitude on the part of young people. Computers and

electronic communications technology are the magic wands and crystal balls of the future. Experimentation ~~Permanenta-tion~~ must be done to decide how these wands and balls are to operate and interface.

PERCEPTUAL LEARNING:

"Eyes Have They, But They See Not", is the title of an article in which Rudolf Arnheim discusses the problem a generation has that has lost touch with its senses. In most schools (with the exception of art, architecture, and design schools) the emphasis on linguistic behavior is so strong that sensory and kinesthetic ~~kinistic~~ behavior is relegated to, at best, a pleasant pastime, and, at worst, as interfering with higher pursuits. Perception is not simply the transmission of outside events , inside to be linguistically processed by the brain,

but a complex process in itself. Scientists strongly rely on visual representation and physical models to aid them in their work. Many discoveries begin with the perception of visual correlation of previously uncorrelated data. Einstein wrote that his initial grasp of the theory of relativity was a kinesthetic image, a certain feeling that he would get through his body. Problem solving as taught at the Bauhaus Institute of Design in Chicago and many other design schools strongly depends on the recording of perception. The point here to be made is not just that students must have more perceptual exercises, but also, that our machines must have much more elaborate input output devices, and perceptually organized

structures, to be efficiently used by humans, and to contribute to a perceptually enriched culture.

MAN MACHINE INTERFACE:

The man machine interface is where human flesh hits steel. It has been little improved since the typewriter. In implementing most activities, man, is strongly dependent upon feedback. For instance, in a simple task of walking across the room and turning on a light switch, one does not measure his present position relative to the light switch and then execute a straight line motion based on that measurement. But instead, one constantly measures his position relative to the light switch and constantly makes small corrections according to his directions.

His ability to execute the task accurately does not strongly depend on the stiffness of his muscles, the texture of the floor, or the weight of the coat he is wearing, but it does depend on the position that the feedback forms from his actions. If man did not use corrective feedback in muscular control, he would be affected by the seemingly irrelevant factors mentioned in the example.

The feedback control model (cybernetic model) can be extended to a great range of human behavior. A property which remains important throughout this extension is that the charactor of the feedback strongly determines the charactor of the behavior. In the design of machines and educational environments, the charactor of the feedback is critically important.

In most educational environments, including the use of conventional teaching machines, the feedback is delayed, not very specific, (i.e. correct, incorrect), and usually applied only upon completion of a task, i.e. grade on a paper. This kind of feedback is very sparse when compared to the feedback associated with driving a car, walking through a forest, or conversing with someone.

An essential feature of feedback control systems is that it has to be able to vary its action in order to optimize the action under feedback. In other words, in order to find out if a particular variable is optimized it is necessary to wiggle the value of some action to see if and in what direction corrections are necessary.

In terms of man machines interfaces the machine must be able to sense variations on the part of the man to be able to return usable feedback. The more precise and detailed the interfacial connection the more precise and detailed the feedback, and, hence, the more precise and detailed the original action can be.

Developement of more perceptually oriented interfaces, and interfaces capable of recognizing and producing ~~new ones~~ nuances of action are necessary to the development of more effective educational machines.

THE MOVE FROM TEACHING TO LEARNING:

In the conventional classroom all activities center around the teacher: he is instructing students, making assignments, etc. Little more needs to be said. We have all experienced classrooms with that structure and they have severe

drawbacks. It is clear that action is necessary to learn. Conventional classrooms limit action. A more contemporary approach is to construct a learning environment, in which the student explores within the environment (with the aid of the teacher). If the environment is sufficiently rich, this exploration is in itself rewarding , and the use of adversive control (threat of failure, etc.) is not a necessity. Most teaching machines and computerized instruction and are modeled after the old-fashioned classroom, rather than being a device that students can use as an exploratory tool or that students can investigate directly. Executing a program on the student, as is with most teaching machines and computerized instruction, does not give the student much feeling of control in the learning process and does not give him much confidence of being able to learn material independently.

It is important to develop educational machines that allow more initiative on the part of students, and are rich enough to be self-reinforcing.

SECTION II

This section describes in detail the characteristics that I feel educational machines should have to effectively deal with the problems mentioned in Section I and other problems. The structure of these machines are significantly different from the structure of teaching machines or demonstration equipment. I have chosen to call these devices design tool learning machines. A table appears below describing the design tool learning machine's concept and comparing it to teaching machines.

Learning Machines	Teaching Machines
MOTIVATION	
The student is able to do what he considers to be something worth doing. A problem or project of his own choice.	Teaching machines usually depend on aversive external rewards, i.e., grade, threats of failure to encourage student to use the machine.
DIRECTION OF ACTION	
The student acts on the machine by structuring it to do a task.	The machine directs the student along prescribed paths with little options left to student discretion.
AVAILABILITY OF STRUCTURE	
The structure of the machine is accesible to the student. This allows him more control of the learning situation.	The structure of the machine (the program and logic behind the program) is inaccesible, contributing to the students lack of control of the situation.

PACING OF STUDENT

Learning Machines	Teaching Machines
The student is in control. He may take as long or as short as he likes. May investigate an area to any depth.	Although the student may go along at his own pace, he cannot skip sections in which he is not interested ~~in~~ (and come back to them later), and can usually not investigate one area to much greater depth than other students executing the same program.

PROBLEM OF VARYING LEVELS OF COMPETENCE

Learning Machines	Teaching Machines
Because of its generalized structure, students of varying levels may interact with the machine profitably.	Must have separate programs tailored to various levels of competency with ~~a tentative~~ attendant placement of problems.

REPERTORY OF STUDENT RESPONSES (input to machine)

Learning Machines	Teaching Machines
Large and varied, including keyboard, joy sticks, biological and environmental sensors.	Limited to a small number of specific operations, i.e., pushing one of 5 or 26 buttons.

Learning Machines		Teaching Machines
	FEEDBACK (outputs of machine which respond to students action)	
Immediate, multi-sensual, unambiguous, and varied. Includes colored kinetic events, tactile, audio, and environmental feedback.		Often delayed and usually limited to correct-incorrect with perhaps some additional information or a program branch.
	GENERALITY	
The machine can accomplish many tasks and can be restructured to accomplish new tasks under student control.		The machine is usually designed for a particular subject and requires reprogramming by other than the student, to new things.
	NUANCE ~~NEW ONES~~	
The machine is capable of sensing small variations of input. (much information is carried in small variations of intonation, gesture, etc.)		Only the teaching machine is sensitive to gross ordering of input information.

THE IMAGE PROCESSOR

The image processor is an example of a design tool learning machine. It was constructed under a grant for innovation in the undergraduate program development of U.I.C.C. It is partially completed but is functioning as of this writing. The explicit content of the instruction performed by this machine is perceptual learning related to two dimensional kinetic images. The implicit content is the structure of linear, as opposed to digital electronic generalized machines, analogue computation, and video technology.

The video image processor is a device which accepts naturalistic images, modifies and combines them in complex ways, and displays or stores the result. A television camera, film train, video tape recorder or similar device can be used to encode ~~decode~~ moving images into a form which the image processor accepts. ~~excepts~~. A television monitor decodes the signal and displays the modified image. The processor itself is composed of modules which do specific

modifications of the image. The instrument is programmed by routing the image through various processing modules and then out to a monitor or tape recorder. The modules are designed to maximize the possibility of interconnection, thereby, maximizing the number of possible modifications of the image.

This description of the image processor may sound like a sophisticated special effects board in a television station. There is, of course, a similarity. A good analogy would be to compare a desk calculator to a general purpose digital computer. Both the desk calculator and computer can add and subtract numbers. The computer, however, can also store a program (which it executes in time) and more importantly can modify its program based on results of the program. The image processor has, in addition, the power to modify images, the power to execute a program in time, and more

DEFINED IN EXPERIENTIAL TERMS

importantly to modify what modification is done based on the content of the input image and the program. The image processor is a general purpose machine and the special effects generator is not.

STUDENTS AND THE IMAGE PROCESSOR

The student usually comes to the image processor with the idea of doing an "art" video tape. The instrument is quite intuitive but not completely self explanatory. (The I.P. needs some improvement on this score.) A one hour video tape is usually sufficient to allow a student to start exploring the possibilities of the machine. After a student ~~can~~ begins to operate the device, the INTERACTION WITH THE device's internal LOGIC ~~structure~~ is sufficient instruction, and the immediate feedback ~~time~~ is sufficient motivation to keep the student exploring for quite awhile. As of this writing the I.P. has been operating for about 4 months. About 7 people have

been introduced to it in detail. (Formal introduction of the I.P. ~~will be formally introduced~~ into the curriculum WILL BE MADE this fall.) Of the 7 people exposed to the image processor, 5 including myself, can only ~~adequately~~ be described ADEQUATELY as being addicted.

What does someone learn using the I.P.? Primarily, a person learns about how images change in time, by electronically disecting and reassembling images. But what a person learns in most detail will depend on what he tried to do with the machine. He might, for instance, explore some relationships between sound and images by using sound inputs to the processor to control image transformations, or he might use an image to control some aspect of sound. The student might instead explore the feeling of and the effects of viewing images controlled by his heart beat or brain waves. He might even explore images combined in a variety of ways.

Because the image processor is a generalized machine and because it is designed to interface with other machines, essentially, it can be used to explore an indefinite range of events in the universe.

PRESENT STATE OF THE IMAGE PROCESSOR

The image processor is not finished. It is presently restricted to black and white and does not have many input devices. Part of this proposal is for the expansion of the image processor to color and to increase its connectiveness with the universe. The expansion will be discussed in Section III.